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Anmelder: TRW Inc., Cleveland, Ohio (V. St. A.)

Vertreter:

Prinz, Dipl.-Ing. Egon; Hauser, Dr. rer. nat. Gertrud;
Leiser, Dipl.-Ing. Gottfried; Patentanwälte, 8000 München

Als Erfinder benannt: Larsen, Arthur Bertel, Red Bank, N. J. (V. St. A.)

Benachrichtigung gemäß Art. 7 § 1 Abs. 2 Nr. 1 d. Ges. v. 4. 9. 1967 (BGBl. I S. 960): —

Prüfungsantrag gemäß § 28 b PatG ist gestellt

dies ist ein sehr wünschenswertes Merkmal, da die Spannungsquellen, die Rechteckwellen abgeben, nicht schwer belastet sind.

Die spezielle Gestaltung des Transformators weist ferner den Vorteil auf, daß eine wirksame Strombegrenzung im Ausgangskreis erreicht wird.

Die Erfindung umfaßt weitere Ziele, Merkmale und Vorteile, die in der folgenden, ins einzelne gehende Beschreibung in Verbindung mit den Figuren der Zeichnung erläutert werden sollen.

Das technische Gebiet, auf das sich die Erfindung bezieht, umfaßt eine Wechselrichterschaltung, die wirksam ist, um eine im wesentlichen von Oberschwingungen freie Sinuswelle zuzuführen, wobei dieser Wechselrichter vergleichsweise einfach, kompakt und leicht ist, außerdem sehr wirksam ist und in einfacher Weise zu steuern ist und zwar entweder manuell oder automatisch. In den Figuren der Zeichnung ist schematisch ein Ausführungsbeispiel dargestellt. Es zeigen:

Fig. 1 ein schematisches elektrisches Schaltbild einer Wechselrichterschaltung gemäß der Erfindung,

Fig. 2 eine Vorderansicht eines Transformators, der in der in Fig. 1 dargestellten Wechselrichterschaltung verwendet wird, wobei die Gestaltung einer Blechkernbaugruppe des Transformators gezeigt ist und die Anordnung eines Paares von Primärwicklungen und einer Sekundärwicklung auf diesem Blechkern,

Fig. 3 eine graphische Darstellung eines Paares von Tastpulsen, die der Wechselrichterschaltung zugeführt werden und eines Paares von Rechteckwellen, die einem Paar Primärwicklungen bei leichter Belastung zugeführt werden,

Die Wechselrichter 21 und 22 sind wirksam, um Rechteckwellen den Wicklungen 15 und 16 zuzuführen und die relative Phase dieser Rechteckwellen wird gesteuert, um den richtigen Ausgang in der Sekundärwicklung 13 zu erzeugen. Um die Wechselrichter 21 und 22 zu steuern, ist eine Tastpulsschaltung 28 vorgesehen, die Tastsignale den Eingangsanschlüssen 29 und 30 des Wechselrichters 21 und den Anschlüssen 31 und 32 des Wechselrichters 22 zuführt. Die Tastpulsschaltung kann automatisch durch ein Signal gesteuert werden, welches dieser Schaltung von den Ausgängen einer spannungsempfindlichen Schaltung 33 und einer stromempfindlichen Schaltung 34 zugeführt wird. Die Eingangsanschlüsse der spannungsempfindlichen Schaltung 33 sind parallel zur Sekundärwicklung 13 geschaltet und die Eingangsanschlüsse der stromempfindlichen Schaltung 34 sind an einen Widerstand 35 angeschlossen, der in Serie zwischen der Sekundärwicklung 13 und der Last 12 liegt.

Eine wesentliche Komponente der Schaltung ist ein Kondensator 36, der parallel zur Sekundärwicklung 13 geschaltet ist. Der Kondensator 36 hat einen derartigen Wert, daß dieser mit der effektiven Induktanz der Sekundärwicklung 13 zusammenwirkt, um bei der gewünschten Betriebsfrequenz einen Parallel-Resonanzkreis zu bilden. Die effektive Induktanz der Wicklung 13 wird gemessen, wenn die Primärwicklungen 15 und 16 kurzgeschlossen sind.

Im Betrieb werden die Rechteckwellen, die in den Primärwicklungen 15 und 16 erzeugt werden, bezüglich der Phase derart gesteuert, daß eine gerade ausreichende Erregung dem abgestimmten oder Resonanz-Sekundärkreis zugeführt wird, um die Lastverluste zu ergänzen, wenn die Ausgangsspannung den gewünschten Wert hat.

In

haben. Ein magnetischer Nebenschluß 46 ist dicht bei der Primärwicklung 15 und der Sekundärwicklung 13 angeordnet, während ein magnetischer Nebenschluß 47 dicht bei der Primärwicklung 16 und der Sekundärwicklung 13 angeordnet ist. Es ist zu erkennen, daß die Sekundärwicklung 13 eine Zuordnung zu den Primärwicklungen 15 und 16 und den magnetischen Nebenschlüssen 46 und 47 hat.

Die magnetischen Nebenschlüsse 46 und 47 schaffen einen Magnetflußweg sowohl für die Primärwicklungen 15 und 16 als auch einen Magnetflußweg für die Sekundärwicklung 13. Durch diese magnetischen Nebenschlüsse 46 und 47 ist mit dem Transformator 14 sowohl eine Strombegrenzung als auch eine Unterdrückung von Oberwellen möglich.

Die Strombegrenzung erfolgt dadurch, daß ein Paar von parallelen Magnetflußwegen gebildet wird, die durch die Linien 48 und 49 für die Primärwicklung 15 dargestellt sind und ferner ein Paar von parallelen Magnetflußwegen, die durch die Linien 50 und 51 für die Primärwicklung 16 angedeutet sind. Wenn die Last 12 zu groß wird, wird lediglich der Abschnitt des Transformator Kern, der von den Flußwegen 48 und 50 beaufschlagt wird, gesättigt, wobei die Flußwege 49 und 51 mit hohem magnetischen Widerstand im wesentlichen nicht beeinflusst werden und dadurch wird der Strom in den Primärwicklungen 15 und 16 begrenzt.

Eine Unterdrückung von Oberwellen wird ebenfalls durch diese neuartige Gestaltung erzielt. Durch die niedrige Impedanz des Kondensators 36 gegenüber Oberwellenspannungen tritt der größte Teil des Oberwellengehaltes der äquivalenten Eingangsspannung (untere Linie der Fig. 3 und 4) an einer effektiven Induktanz auf, die von dem Magnetfluß-

Der

Patentansprüche

1. Wechselrichter zur Zuführung einer Wechselspannung zu einer Last, gekennzeichnet durch einen Transformator, der einen Kern aus einem magnetischen Material aufweist, eine Sekundärwicklung an diesem Kern, die mit der Last verbunden ist, ein Paar Primärwicklungen an diesem Kern, die induktiv mit der Sekundärwicklung gekoppelt sind, einen Kondensator, der parallel zur Sekundärwicklung geschaltet ist, um einen abgestimmten Sekundärkreis zu bilden, Einrichtungen, um ein Paar Rechteckwellen den Primärwicklungen zuzuführen und Einrichtungen, um die relative Phase dieser Rechteckwellen zu steuern, um eine ausreichende Erregung des abgestimmten Sekundärkreises zu liefern, um die Belastung und die Verluste im Sekundärkreis auszugleichen, wenn die Ausgangsspannung den gewünschten Wert hat.
2. Wechselrichter zur Zuführung einer Wechselspannung zu einer Last, gekennzeichnet durch einen Transformator, der einen Kern aus magnetischen Material hat, eine Sekundärwicklung an diesem Kern, die mit der Last verbunden ist und ein Paar Primärwicklungen an diesem Kern, die induktiv mit der Sekundärwicklung gekoppelt sind, einen Kondensator, der parallel zur Sekundärwicklung geschaltet ist, um einen abgestimmten Sekundärkreis zu bilden, Einrichtungen, um ein Paar Rechteckwellen den Primärwicklungen zuzuführen, Einrichtungen, um die relative Phase dieser Rechteckwellen zu steuern, um eine ausreichende Erregung des abgestimmten Sekundärkreises zu liefern, um die Belastungsverluste und die Verluste im Sekundärkreis auszugleichen, wenn die Ausgangsspannung den gewünschten Wert hat, magnetische Nebenschlüsse, die an dem Kern vorgesehen sind, um einen Magnetflußweg zu bilden, der die Primärwicklungen unabhängig von der Sekundärwicklung miteinander verbindet.

zu bilden, Einrichtungen, um ein Paar Rechteckwellen dem Paar Primärwicklungen zuzuführen, Einrichtungen, um die relative Phase dieser Rechteckwellen zu steuern, um eine ausreichende Erregung dem abgestimmten Sekundärkreis zuzuführen, um die Verluste im Sekundärkreis und die Lastungsverluste auszugleichen, wenn die Ausgangsspannung den gewünschten Wert hat, magnetische Nebenschlüsse, die am Kern vorgesehen sind, um einen Magnetflußweg zu bilden, der die Primärwicklungen unabhängig von der Sekundärwicklung miteinander verbindet, wobei die magnetischen Nebenschlüsse teilweise durch das magnetische Material und teilweise zumindest durch einen Luftspalt gebildet sind.

5. Wechselrichter zur Zuführung einer Wechselspannung zu einer Last, gekennzeichnet durch einen Transformator, der einen Kern aus magnetischem Material aufweist, eine Sekundärwicklung am Kern, die mit der Last verbunden ist, ein Paar Primärwicklungen am Kern, die induktiv mit der Sekundärwicklung gekoppelt sind, einen Kondensator, der parallel zur Sekundärwicklung geschaltet ist, um einen abgestimmten Sekundärkreis zu bilden, Einrichtungen, um ein Paar Rechteckwellen den Primärwicklungen zuzuführen, Einrichtungen, die auf die Ausgangsspannung ansprechen, um die relative Phase dieser Rechteckwellen zu steuern, um eine ausreichende Erregung dem abgestimmten Sekundärkreis zuzuführen, um die Verluste des Sekundärkreises und die Lastungsverluste auszugleichen, wenn die Ausgangsspannung einen vorbestimmten Wert hat.

6. Wechselrichter zur Zuführung einer Wechselspannung zu einer Last, gekennzeichnet durch einen Transformator, der einen Kern aus magnetischem Material hat, eine Sekundärwicklung am Kern, die mit der Last verbunden ist, ein Paar Primärwicklungen am Kern, die induktiv mit der Sekundär-

wicklung

Fig-1

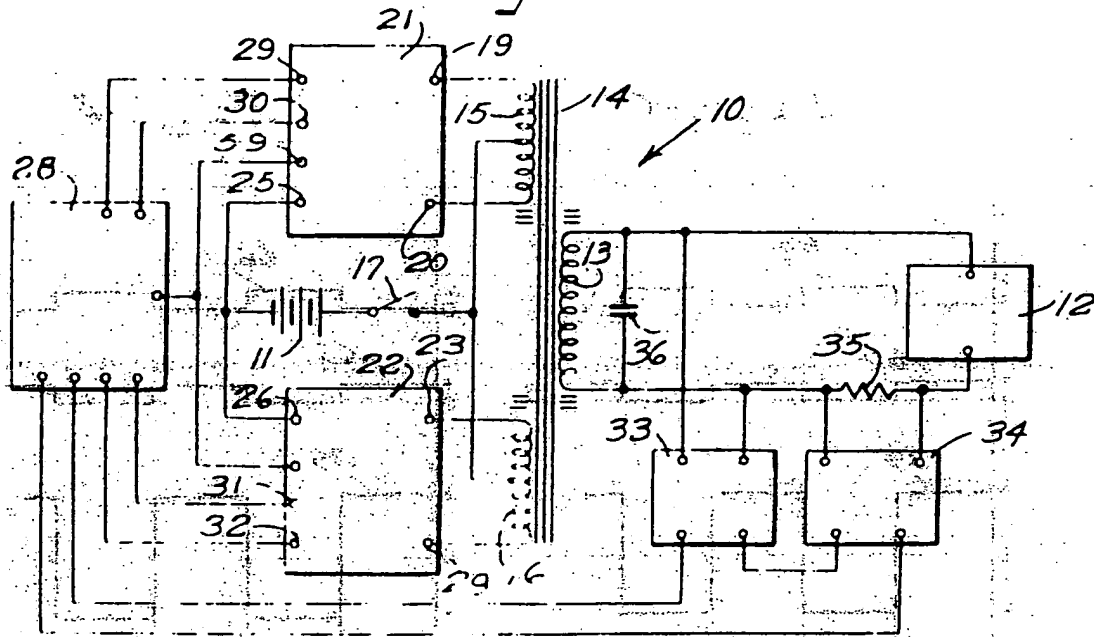


Fig-2

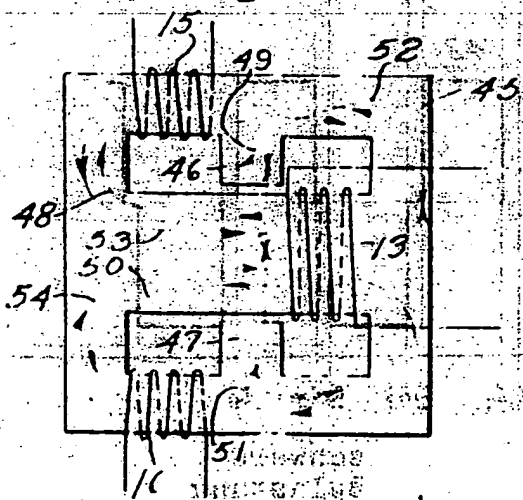
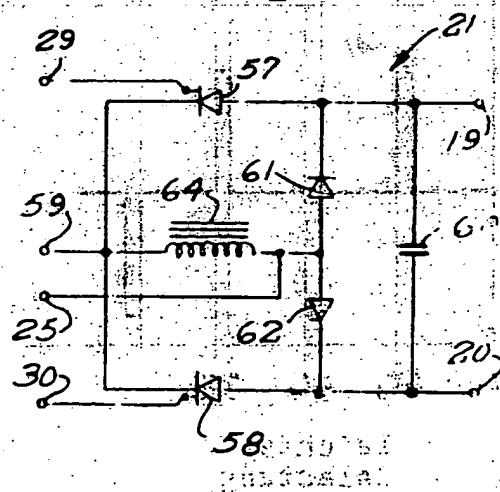


Fig-5



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Power Inverter

One very important feature of this invention is the use of a specially designed transformer where the core is made of a magnetic material with a pair of exterior sections used for primary windings and a middle section used for secondary windings. The area between the exterior sections and the middle section shall form a path for magnetic flux which joins the primary windings independently from the secondary windings and also forms a path for magnetic flux for the secondary winding that doesn't connect the primary windings.

Due to the magnetic side sections between primary and secondary windings harmonic voltage is suppressed efficiently at the exit. These magnetic sections allow for a magnetic flux with harmonic frequencies through the main flux pathway without being connected to the secondary winding. As a consequence harmonic voltages are only generated at the primary windings. This is a very desirable feature as the voltage sources that emit squared waves are not heavily loaded. Additionally this special design of the transformer has the advantage that an efficient limitation of electric current at the output circuit (??) can be achieved.

The invention comprises further target, features and advantages that shall be explained in detail together with the drawings in the diagrams as follows:

Technically speaking the invention ^{upper harmonic circuit} refers to an inverter wiring (??) with the purpose of creating a ^{sinusoidal wave} sinus curve that is essentially free from upper oscillation, whereas this power inverter is comparably simple, compact, light in weight, very efficient and easy to regulate either manually or automatically. The technical drawings in the diagrams show a schematic plan of the design.

Fig. 1: A diagram showing a schematic electric circuit of the power inverter wiring according to the invention.

Fig. 2: Front view of a transformer which uses the power inverter shown in Fig. 1. It shows the design of the steel core of the transformer and the positioning of a pair of primary windings and a secondary winding on this core.

Fig. 3: A graphic display of a pair of pulse-contacts that are added to the ballast and a pair of squared waves that are induced onto a pair of primary windings under a light loading.

Fig. 4: A graphic display of a pair of pulse-contacts induced onto the power inverter wiring (or regulator??) and a pair of squared waves induced onto the primary windings under heavy loading.

Fig. 5: A power inverter wiring that can be used with the wiring displayed in Fig. 1 in order to generate squared waves that can be induced on the primary windings of a transformer.

Firstly it shall be referred to Fig. 1. (10) is a power inverter wiring developed according the invention that has the purpose of transforming DC coming from the battery (11) into AC under a loading (12). The power inverter wiring is comparably simple and light though extremely efficient. Furthermore this power inverter functions in such a way that a sinus curve free from upper oscillations is induced and the output (exit?) of this wiring can be simply regulated either manually or automatically.

The loading (12) is connected to the ^{central tap} secondary winding (13) of a transformer (14) that shows a pair of primary windings (15, 16) with a neutral bar (????). The neutral bars (??) are connected to the positive pole of the battery (11) via a switch (17). The end terminations of the primary winding (15) are linked with terminations (19 + 20) of a first power inverter (21) while a second power inverter (22) shows terminations (23 + 24) that are connected to the end terminations of winding (16). The connections (25 + 26) of power inverters (21 + 22) are connected to the negative pole of the battery (11).

Power inverters 21 + 22 are used for inducing squared waves onto windings 15 + 16. The relative phase of these squared waves is regulated in order to create the correct output (exit?) in the secondary winding 13. In order to regulate power inverters 21 + 22 a pulse-contact switch is used to send out tactile signals to the entrance terminations 29 + 30 of power inverter 21 and to terminations 31 + 32 of power inverter 22. The pulse-contact switch can be operated automatically through a signal which is introduced to this switch through the exit (output ?) of a voltage sensitive switch 33 and a current sensitive switch 34. The entrance terminations of the voltage sensitive switch 33 are parallelly connected to the secondary winding 13. The entrance

terminations of the current sensitive switch 34 are connected to a resistance 35 which is connected in series between secondary winding 13 and loading 12.

An essential component of the wiring is a condenser ³⁶(36) that is connected parallelly to the secondary winding (13). The capacitor unit (36) has such a value that it works in combination with the effective induction of the secondary winding (13) to form a parallel resonance circle at the desired operational frequency. The effective induction of the winding (13) is measured when the primary windings 15 + 16 are short-circuited. Regarding the phase, in operation the squared waves generated by the primary windings 15 + 16 are regulated in such a way that a just about sufficient excitation (impulse?) is induced on the tuned or resonance secondary circuit in order to complete the loading losses when the exit voltage has reached the desired value.

Fig. 3 shows graphically the squared waves 39 + 40 that are induced on primary windings 15 + 16 with a light loading. The squared waves 39 + 40 are mainly shifted out of phase in order to induce an equivalent entrance (input???) (taken as a whole) for primary windings 15 + 16 that shows short positive and negative pulses. This is indicated by wave 41.

During the time interval t_0-t_1 both squared waves 39 + 40 have the same amplitude. However, one is positive and the other is negative. Therefore the resulting signal induced on primary windings 15 + 16 equals zero in total. At the time t_1 the squared wave 40 changes its polarity and coincides with squared wave 39. Thus an equivalent entrance (input??) is supplied for primary windings 15 + 16 which, as a whole, has the form of a short pulse 41.

Fig. 4 shows graphically the squared waves 39 + 40 that are induced with a heavy loading on primary windings 15 + 16. The squared waves 39 + 40 are now generally in phase in order to generate an entrance (input?) pulse 42 of relatively long duration as a whole in the primary windings 15 + 16. The operational procedure during the time intervals t_0-t_1 & t_1-t_2 corresponds to the previously described operational procedure.

A very essential feature of the invention is the construction of transformer 14 which is schematically shown in Fig. 2. Primary windings 15 + 16 and secondary winding 13 are fixed on a common steel core module 45. Primary windings 15 + 16 are placed on the core module in such a way that they have the same counter induction with secondary winding 13. A magnetic side termination 46 is closely situated next to primary winding 16 and secondary winding 13. It can be seen that secondary winding 13 is related (delegated?) to primary windings 15 + 16 and the side terminations 46 and 47.

The magnetic side terminations 46 + 47 create a path for magnetic flux for primary windings 15 + 16 as well as a path for magnetic flux for the secondary winding 13. Through these magnetic side terminations 46 + 47 together with transformer 14 it becomes possible to limit the electric current and also to suppress upper oscillations.

The limitation of the electric current is effected through the creation of two parallel paths for magnetic flux which is represented by lines 48 + 49 for the primary winding 15 AND further through two parallel paths for magnetic flux that are indicated by lines 50 + 51 for the primary winding 16. If the loading 12 becomes too heavy, only that section of the core of the transformer that is 'utilised' by the flux paths 48 + 50 is saturated whereas flux paths 49 and 51 with a high magnetic resistance are generally not influenced. As a result the electric current in the primary windings 15 + 16 is limited.

A suppression of the upper oscillations can also be achieved because of this new design. Due to the low impedance / impediment (??) of capacitor 36 with regard to upper oscillation voltages the greatest part of the upper oscillation content (?) of the equivalent entrance (input?) voltage (lower line of Fig. 3 + 4) occurs at an effective induction that is carried by a path for magnetic flux 52. The harmonic voltages at such an effective induction suppress the upper oscillation content from reaching loading 12.

In operation power inverters 21 + 22 will transmit squared waves 39 + 40 to primary windings 15 + 16 of transformer 14. During time interval t_0-t_1 , the path for magnetic flux which is indicated by line 53 and the path for magnetic flux 50 run in opposite directions. This has an extinguishing effect and thus an equivalent entrance for primary windings 15 + 16 is created which as a whole has the value zero. At t_1 the squared wave 40 becomes positive and the magnetic flux 50 is reversed in the direction of line 54. During the time interval t_1-t_2 the magnetic fluxes 53 and 54 are additive and induce a counter induction in the secondary winding 13 which is equivalent to the positive pulse 41 in Fig. 3. At t_2 the squared wave 39 becomes negative which has the effect that the magnetic flux 53 is reversed into the direction indicated by line 48. During the time interval t_2-t_3 the magnetic fluxes 48 and 54 run in opposite direction which has an extinguishing effect and an entrance (input?) equivalent of the value zero is generated. At t_3 the squared wave 40 becomes negative and causes a reversed magnetic flux 54 in the direction indicated by line 50. During the time interval t_3-t_4 magnetic fluxes 50 and 48 are additive and cause a counter induction in the secondary winding which is equivalent to the negative pulse

41 in Fig. 3. At L₄ the squared wave 39 becomes positive again and thus causes an automatic repetition of the previously described operation.

Fig. 5 shows a typical construction of a power converter wiring 21 that can be used to generate squared wave 39. A pair of controlled silicon rectifiers 57 + 58 show cathodes that are connected to a mutual termination 59. The anodes of these rectifiers are connected to terminations 19 + 20. Terminations 19 + 20 are likewise connected to a switch capacitor 60 and also with the cathodes of a pair of rectifiers 61 + 62. The anodes of rectifiers 61 + 62 are connected to termination 25 of a switch induction 64. The other end of induction 64 is connected to termination 59.

In operation a pulse-contact 65 (Fig. 3) is installed between terminations 29 + 59. Therefore the rectifier 57 becomes conductive and thus a positive squared wave is induced on primary winding 15 of transformer 14. At a set time pulse-contact 65 is disrupted and a pulse-contact 66 is installed between terminations 60 + 59 (?). As a consequence rectifier 58(?) becomes conductive whereas rectifier 57 is then switched off by switch capacitor 60 and the switch induction 64 this is effected in a way as it can be observed with solid power inverter switches. Thus a negative squared wave is induced on primary winding 15 of transformer 14. The power inverter wiring 22 can be of the kind as it is displayed in Fig. 5 in order to generate squared wave 40 which is induced on primary winding 16 of transformer 14.

Pulse-contact 28 and the voltage- and electric current sensitive switches 33 + 34 can be constructed according to Fig. 3 of the USA Patent Form 3 181 053, whereas the voltage- and electric current sensitive switches regulate „reverse2 voltages (?) that are induced on magnetic amplifiers in order to regulate the relative duration of the tact of the pulse-contacts. Notice that other pulse-contact switches and voltage-contact switches and electric current contact switches can be used.

PATENT CRITERIA

- 1.) Power inverter for induction of an alternating voltage on a loading, characterized by a transformer with a core made of magnetic material; a secondary winding on this core that is connected to the loading; a pair of primary windings on this core that is coupled inductively with the secondary winding; a capacitor that is connected in parallel with the secondary winding in order to form a harmonic secondary circuit; appliances that induce a pair of squared waves on the primary windings and appliances to regulate the relative phase of these squared waves on the primary windings and appliances to regulate the relative phase of these squared waves in order to induce sufficient excitation on the harmonic secondary circuit with the purpose of compensation for the loading and losses in the secondary circuit once the output / exit (?) voltage has reached the desired value.
- 2.) Power inverter for induction of an alternating voltage on a loading, characterized by a transformer with a core made of magnetic material, a secondary winding on this core that is connected to the loading; a pair of primary windings on this core that is coupled inductively with the secondary winding; a capacitor that is connected in parallel with the secondary winding in order to form a harmonic secondary circuit; appliances that induce a pair of squared waves on the primary windings and appliances to regulate the relative phase of these squared waves on the primary windings and appliances to regulate the relative phase of these squared waves in order to induce sufficient excitation on the harmonic secondary circuit with the purpose of compensation for the loading and losses in the secondary circuit once the output / exit (?) voltage has reached the desired value; magnetic lateral / (side ?) terminations on the core in order to create a path for magnetic flow which connects the primary windings independently from the secondary winding.
- 3.) Power inverter for induction of an alternating voltage on a loading, characterized by a transformer with a core made of magnetic material, a secondary winding on this core that is connected to the loading; a pair of primary windings on this core that is coupled inductively with the secondary winding; a capacitor that is connected in parallel with the secondary winding in order to form a harmonic secondary circuit; appliances that induce a pair of squared waves on the primary windings and appliances to regulate the relative phase of these squared waves on the primary windings and appliances to regulate the relative phase of these squared waves in order to induce sufficient excitation on the harmonic secondary circuit with the purpose of compensation for the loading and losses in the secondary circuit once the output / exit (?) voltage has reached the desired value. The core shows a few exterior sections that hold the primary windings and a middle section between the exterior sections for the secondary winding. A pair of lateral / (side ?) termination sections between the exterior sections and the middle section are placed in such a way to form magnetic paths for flux that connect the primary windings independently from the secondary winding and

at the same time they form magnetic paths for flux for the secondary winding that doesn't connect the primary windings.

- 4.) Power inverter for induction of an alternating voltage on a loading, characterized by a transformer with a core made of magnetic material; a secondary winding on this core that is connected to the loading; a pair of primary windings on this core that is coupled inductively with the secondary winding; a capacitor that is connected in parallel with the secondary winding in order to form a harmonic secondary circuit; appliances that induce a pair of squared waves on the primary windings and appliances to regulate the relative phase of these squared waves on the primary windings; and appliances to regulate the relative phase of these squared waves in order to induce sufficient excitation on the harmonic secondary circuit with the purpose of compensation for the loading and losses in the secondary circuit once the output / exit (?) voltage has reached the desired value; magnetic lateral terminations on the core to form the path for magnetic flux that connects the primary windings independently from the secondary winding, whereas the magnetic lateral terminations are partly formed by the magnetic material and at least partly by an air gap.
- 5.) Power inverter for induction of an alternating voltage on a loading, characterized by a transformer with a core made of magnetic material; a secondary winding on this core that is connected to the loading; a pair of primary windings on this core that is coupled inductively with the secondary winding; a capacitor that is connected in parallel with the secondary winding in order to form a harmonic secondary circuit; appliances that induce a pair of squared waves on the primary windings; appliances that are sensitive to the voltage at the exit in order to regulate the relative phase of these squared waves in order to induce sufficient excitation at the harmonic secondary circuit and in order to compensate for the losses at the secondary circuit and for loading losses once the voltage at the exit has reached the desired value.
- 6.) Power inverter for induction of an alternating voltage on a loading, characterized by a transformer with a core made of magnetic material; a secondary winding on this core that is connected to the loading; a pair of primary windings on this core that is coupled inductively with the secondary winding; a capacitor that is connected in parallel with the secondary winding; a pair of power inverter switches that are connected to the primary windings whereas each of these switches has a pair of rectifiers that become alternately conductive in order to generate squared waves at the primary windings; appliances to regulate the relative phase of these inverter switches in order to induce sufficient excitation on the harmonic secondary circuit and to compensate for the loading losses once the voltage at the exit has reached the desired value.